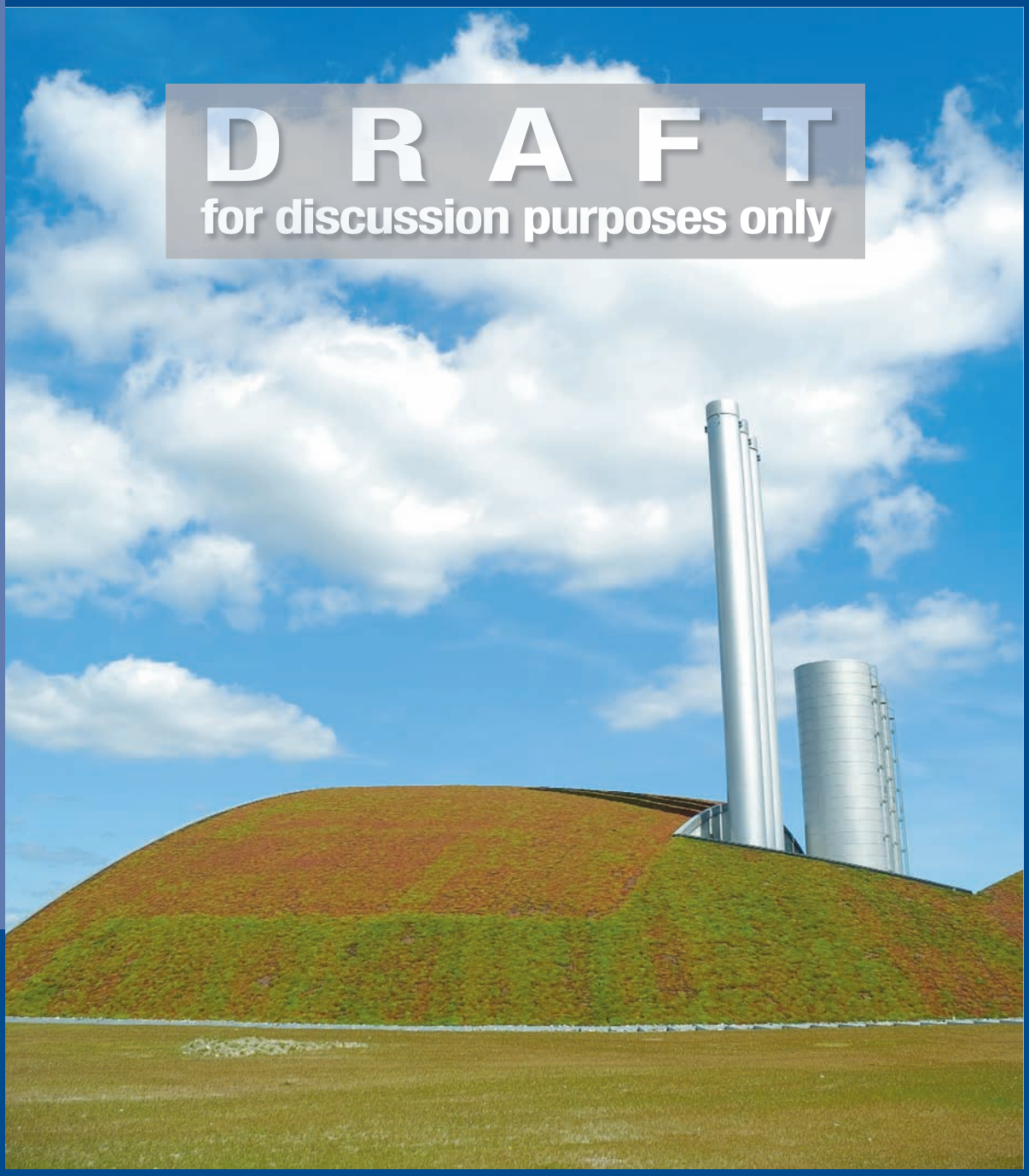
Supporting Materials

California Education and the Environment Initiative

6

Science Standard 6.6.c.



Made from Earth: How Natural Resources Become Things We Use

D R A F T
for discussion purposes only

California Education and the Environment Initiative

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Contents

Assessments

Lesson 1 What a Resource!

Activity Masters

Visual Aids

Lesson 2 From Natural Resource to Store Shelf

Activity Masters

Visual Aids

Lesson 3 World Travelers

Visual Aids

Lesson 4 Meet the Extractors and Harvesters

Activity Masters

Visual Aids

Lesson 5 The Effects of Consumption

Activity Masters

Visual Aids

Lesson 6 What Does It Cost?

There are no new Activity Masters or Visual Aids required for this lesson.

Name: _____

Matching: Draw lines to match these materials used in common objects to their natural (resource) origins. More than one common object can come from one resource: (2 points each)

1. aluminum
2. cardboard
3. leather
4. plastic
5. rubber (natural)

animals

fossil fuels

mineral ores

plants

Name a product that is made from each of these natural or raw materials: (2 points each)

6. copper _____
7. cotton _____
8. petroleum _____
9. silica sand _____

10. These are the steps involved in the manufacturing of an iron pot. Put the steps in the correct order by numbering them from 1 to 4, 1 being the first step. (2 points)

    _____ Pure iron is transported to a factory.

    _____ Iron ore is extracted from Earth by mining.

    _____ The iron is melted and poured into a mold in the shape of a pot.

    _____ Iron ore is heated and refined to extract pure iron.

Name: _____

Multiple Choice: Read each question and circle the letter of the best answer. (3 points each)

11. Which method of transportation is used most by extractors, harvesters, and manufacturers to get materials and products from place to place?
    a. aircraft
    b. trucks
    c. trains
    d. ships

12. Which ecosystem is most likely to be a source of wood?
    a. a sawmill
    b. paper
    c. a forest
    d. a lake

13. Mineral ores are extracted _____.
    a. from Earth
    b. using feller bunchers
    c. from farms
    d. using ships

14. Which of the following is not harvested from plants to make products?
    a. fiber
    b. oil
    c. sap
    d. sand

Name: _____

Short Answer: Answer the question below in one paragraph. (8 points)

15. How can making a surfboard affect natural systems?

Name: _____

As a new expert in how natural resources become products, your new job is to make a model or detailed blueprint of the toy that your new toy company is going to build.

Your models and blueprints are due at a Toy Showcase on _____.
(deadline date)

Models: If you are making a model of your toy, the model should be the actual size of the toy and include all of the toy's key parts.

Blueprints: If you are making a blueprint, your drawings should be done on chart-size paper, and use measurements to show the size of the actual toy. Like the model, the blueprint should show all key parts of the toy.

All models or the blueprints must be turned in with the following information:

- the name of the toy.
- the **resources** and **raw materials** you are using for each part in the real toy
- the **ecosystems** where those resources and raw materials will come from.
- how those resources will be **extracted**, **harvested,** and **transported**.
- how the making of this toy might **affect** natural systems.

Create tags to stick on your model or make typed labels for the blueprint that have this information on them. You may hand-write or word-process the information on the tags and labels.

Use your **Manufacturing and Design Journal** to help you and do not forget to bring your journal to the Toy Showcase along with your model or blueprint.

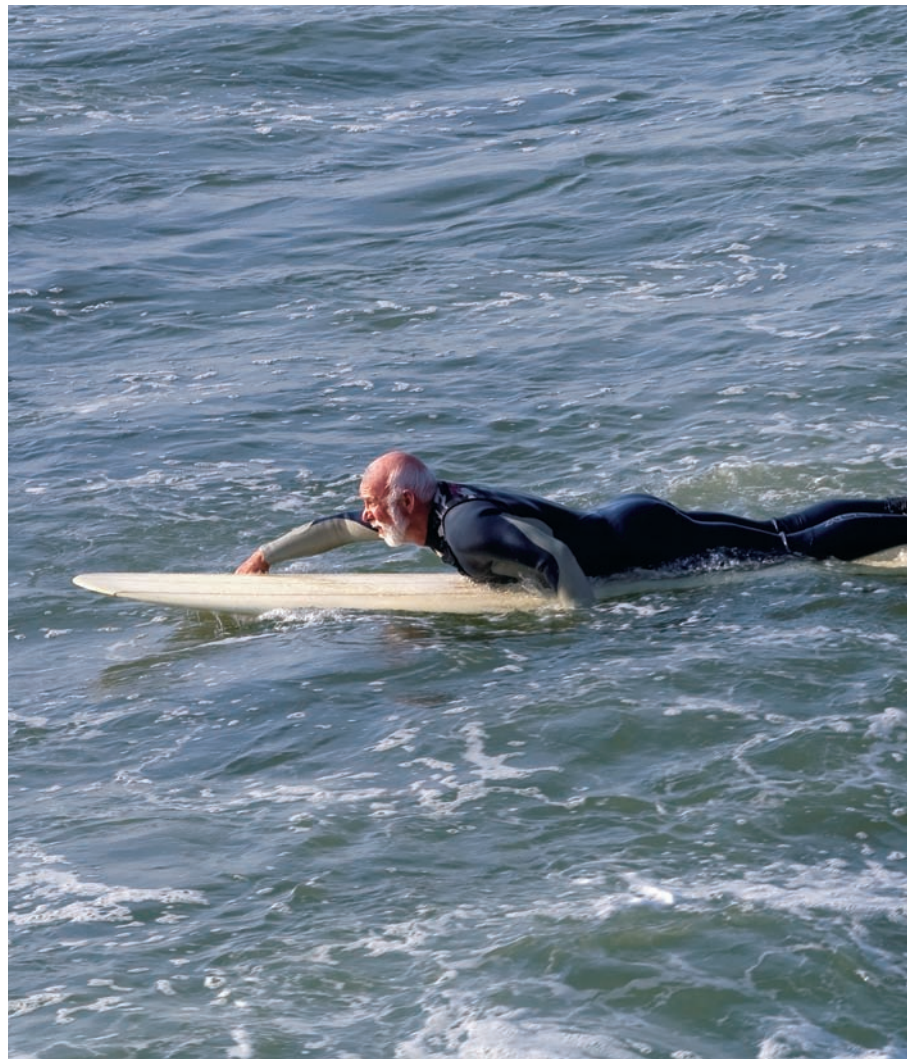
Good Luck, Toy Maker!

California Connections: A Surfboard Story

If you have walked along a California beach, you have probably seen surfers paddling out to catch a wave. As you watched their surfboards bob up and down in the water, did you ever wonder what makes those boards so tough, even though they are relatively lightweight? If you researched your question, you would learn that it takes only a few materials to make a surfboard.

A big part of surfboards is polyurethane, which comes from the natural resource oil. This oil was formed long ago in ancient oceans, perhaps right here in California. Marine animals that died millions of years ago drifted down to the ocean floor. Heavy layers of sand trapped the dead animals' bodies in airtight pockets. The heavy sand and water pressed down and over long periods created fields of sticky black oil.

Skip forward a few million years. Now in many areas of California, as well as off the coast, people extract this oil with drilling rigs. When workers first install a rig, pressure from the site forces the crude oil to the surface. Over time this pressure decreases. When the pressure drops too low to force the oil



Surfer paddling

Oil rig drilling near the Channel Islands

upward, workers add a rocking arm and continue to pump the oil from the ground.

The crude oil often contains materials that people cannot use. Workers remove these unwanted materials by putting the oil in settling tanks or separators. Then they ship the oil by pipeline or by truck to a refinery.

Manufacturers purchase some of the oil to make polyurethane, a chemical compound used in foams, elastics, and resins, and the key ingredient in most modern surfboards. The manufacturer usually ships the polyurethane by truck or train to a wholesaler, who unloads it and stores it for later sale.

From the wholesaler, truck drivers take the polyurethane to a surfboard manufacturer. In the surfboard factory, workers heat the polyurethane in a cement mold for 25 minutes. The heat triggers a chemical reaction and dense, white foam begins to froth. After it cools, builders use this foam to make the core of the surfboard.

The builders slice this white foam core (also called a blank) in two, lengthwise, like deli bread. A 1/8-inch piece of wood acts as the "meat" in this "surfboard sandwich" when builders glue it into place. The builders then clamp the surfboard shut to allow the glue to dry. The stringer prevents the surfboard from breaking in half.

Fiberglass Facts

As the surfboard hardens, you have time to look at the resources used to make the stringer. The process of making fiberglass uses three major ingredients: limestone, soda ash, and silica sand.

Like oil, limestone forms from the remains (shells

and bones) of ancient sea creatures. Wave action breaks up the shells and bones of marine animals and deposits the pieces on the ocean floor. Over millions of years, layers of shells, sand, and mud harden into limestone. People extract this abundant resource from many different places. Sometimes quarry workers take it from deposits on Earth's surface. In other places, miners extract limestone from underground deposits or caves.

Extracting soda ash is much different from limestone mining. In nature, soda ash is often invisible, since it dissolves in some lakes or accumulates in salt beds. People extract its white powder from these natural sources. However, scientists can also create soda ash in a lab.

The third key material in fiberglass is silica sand, which contains a lot of quartz. Over many years wind and water slowly grind quartz rocks into silica sand. People extract the silica sand from beaches, riverbeds, and lakes.

Mining companies use trucks or trains to ship the three minerals used to make fiberglass to wholesalers. The wholesalers sell the minerals and load them back onto trucks. The truckers deliver the minerals to the fiberglass manufacturer, where workers unload and store the minerals until they are needed.

Creating Glass Threads for Fiberglass

The manufacturer carefully weighs each raw material to get the exact quantities needed to make fiberglass. The workers mix the ingredients together and feed the batch into a furnace. To make glass fibers, the temperature must be very hot—approximately 2,500ºF (1,371ºC).

When the silica sand melts, it forms liquid glass. The molten glass goes into a machine with hundreds of small holes. The machine

Cutting fiberglass wrap

Finishing fiberglass

draws the glass through the holes, creating thin strands, or threads. These threads go into making many different fiberglass products. Workers load the products onto delivery trucks and ship them to manufacturers such as the surfboard maker.

Meanwhile, Back at the Surfboard Sandwich

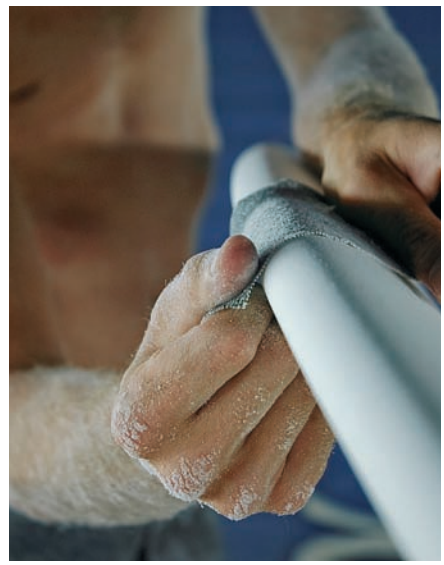
Now that the surfboard core and stringer are dry, a saber saw cuts around the drawing of the outline of the surfboard. Then a motorized planer levels out the final shape. (A planer is a machine that evens things out.)

A big sander goes to work next, repeatedly sanding to remove ridges from the surfboard blank. As a last step in shaping, builders mark the position of the surfboard's fin. Many builders add their own special designs, or signatures, to identify their work. Then they blow the finished blank clean with compressed air.

To make the surfboard colorful, builders spray on paint with an airbrush or spray gun. Then they dry the surfboard once more.

The key to making the surfboard last a long time comes in the next stage, called glassing. In glassing, builders layer fiberglass sheets and resin. Resin is a thick fluid produced by plants or, more commonly, manufactured from oil-based chemicals. Resin is strong and keeps the surfboard from chipping or cracking.

After glassing, builders coat the board with one more layer of resin to plug any flaws on the standing surface, called the deck. They flip the board over and position the fin. Next the builders wrap fiberglass tape around the fin and add resin to it. Finally they coat the surfboard's underside and fin with a filler layer of shellac which is made from trees. Later, when the entire surfboard is dry, the builders drill a small hole in the tail for a leg leash.



Final sanding

Woman surfing

A final round of sanding removes any excess resin. More dust flies as the compressed air puffs the board clean. The builders add decals and graphics before brushing a final coat of shiny gloss resin over the board in the last 15 minutes before it hardens.

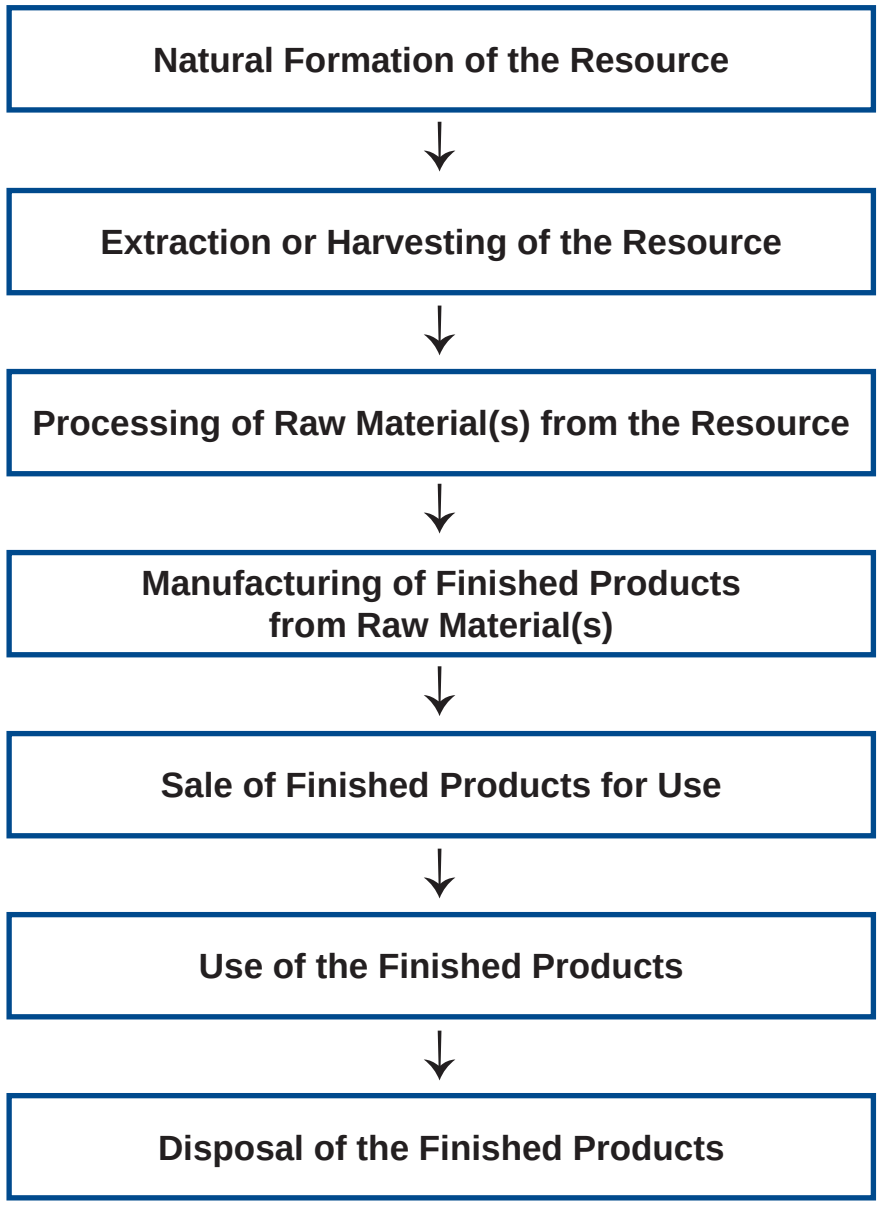
In another 12 hours the surfboard receives its final rubbing, buffing, and polishing. Later, workers stack it with other finished surfboards, where they wait to be loaded onto trucks and delivered to surf shops around California and the country.

Surfboard Shopping

Two weeks later, a surfer walks into a surf shop. She tells the clerk she wants a sturdy surfboard, but one that is easy to carry. Thirty minutes later, she tucks her new surfboard under her arm and walks out of the shop to her buddies. They drive to the beach, unload their gear, and get ready to paddle out past the breakers.

Sitting on the shore with a friend, you look up a little while later to see this surfer carefully stand for the first time on her new surfboard. As she steadies herself, you turn to your friend and smile as you ask, “Hey, dude, do you know how surfboards are made?” When he shrugs, you say, “Well, it all began in an ocean a lot like this one millions of years ago…”

Natural Resources Use Flowchart



Origins Chart

Raw material yielded	Natural resource category	Common uses in manufactured products	Method of extraction or harvesting
Bauxite	Mineral ore	Aluminum objects	Surface mining
Clay	Mineral ore	Dinnerware, pottery, tiles for floors and walls, buildings	Surface mining
Copper	Mineral ore	Electrical wires, batteries, cookware, plumbing pipes, coins	Surface mining
Cotton	Plant	Thread, fabric, batting, oil (cottonseed), cottonseed meal (used in livestock feed)	Collecting the seed pod from the plant
Gelatin	Animal	Glue	Rendering animal bones
Graphite	Mineral ore	Pencil lead (which contains graphite, not lead), batteries, lubricants and paint	Surface mining
Iron	Mineral ore	Frames for buildings, bridges, and other structures, tools, cookware, steel, batteries and magnets	Surface mining
Leather	Animal	Clothing, bags, fasteners	Skinning the hide from dead livestock

Origins Chart

Raw material yielded	Natural resource category	Common uses in manufactured products	Method of extraction or harvesting
Limestone	Mineral ore	Fiberglass, building, roads, landscaping, and cement	Surface mining
Petroleum	Fossil fuel	Plastics, paints, synthetic fabrics (PVC), synthetic rubber, foams, thread,	Deep drilling
Resin (rosin)	Plant	Shellacs, cements, musical instrument strings	Collecting the sap from living trees
Rubber (natural)	Plant	Tires, gaskets, insulation, elastic fabrics and fasteners, foams, hoses	Collecting the sap from living trees
Silica/Quartz	Mineral ore	Glass (and fiberglass), silicon for computer chips, jewelry, lenses, concrete, electronics, abrasives	Surface mining
Soda ash	Mineral ore	Glass (and fiberglass), and food sweetener	Underground mining
Tin	Mineral ore	Cans, containers, soldering material	Surface mining
Wood/timber	Plants	Houses, floors, furniture, tools, paper	Cutting the stalk off the root (logging)

Assignment

Congratulations! You are the new owner of a toy company that makes toys for young children. The first decision you will need to make in your new job is what new toy you want to add to your toy line. Your company can make **one** of the following kinds of toys:

- **Stuffed animal** or **action figure**
- **Sports equipment** (balls, rackets, clubs, bats, etc.)

Over the next few lessons, you will design a plan to produce your toy. Your plan will include all stages of manufacturing. These stages will include extracting or harvesting the natural resources and raw materials you need, getting the resources to the factory, and putting the toy together.

Follow these steps to get started:

1. Decide on the type of toy your company will make. Write the name and type of toy here:

   _____

2. List the parts of your toy in the first column, below. Make sure you include at least three parts. Using the Origins Chart on Page 3 as a guide, identify the raw materials and natural resources you might use to make each part of your toy. Try to think of at least two possibilities for materials. You will be able to change your choices later.

Parts of toy	Natural resources/raw materials needed for parts

Name: _____

1. Which material do you want to use for your surfboard *blank* (*deck, nose and tail*)? (Check one)

_____ **Polyurethane foam:** Polyurethane foam is one of the easiest materials to shape. Decks made from polyurethane have a smooth finish, which surfers like. Polyurethane is also the least expensive of the materials used for the body of a surfboard. Polyurethane foam is made from petroleum, which is a fossil fuel.

_____ **Polystyrene foam:** Polystyrene is used to make the foam cups you might get at take-out restaurants in some cities. It is one of the most lightweight options available for building surfboards, which means that surfboards made from polystyrene float well in the ocean. Some polystyrene absorbs a lot of water and polystyrene is not as strong as polyurethane foam. To make it stronger and more waterproof, manufacturers seal the outside of polystyrene blanks with fiberglass. But even a tiny hole in the fiberglass shell can ruin a surfboard. Polystyrene is also made from petroleum, a fossil fuel.

_____ **Wood:** Wood comes from plants and is a renewable resource. In some types of well-managed forests, trees can grow back as fast as people cut them. Wood is strong and floats, but a wood surfboard is a lot heavier than one made of foam. According to some surfers, wood boards do not perform as well as foam boards. It can also be more expensive to make a surfboard out of wood than out of foam.

_____ **Biofoam:** Biofoam is made from the sap of plants, which is renewable. This type of foam is easy to shape and has a smooth finish, but can vary in color and in how paint sticks to it. Biofoam can be mixed with polyurethane foam to make it stronger and more even in color.

2. Which material do you want to use for your surfboard *stringer*? (Check one)

_____ **Wood:** Wood is a renewable resource with strength and flexibility, but it is expensive.

_____ **Epoxy with fiberglass:** Epoxy is made from petroleum, like polystyrene foam. It is easy to cut. Fiberglass is made from glass threads. Petroleum is a fossil fuel and silica, which goes into the glass, is a mineral ore. Both are less expensive and lighter in weight than wood.

Name: _____

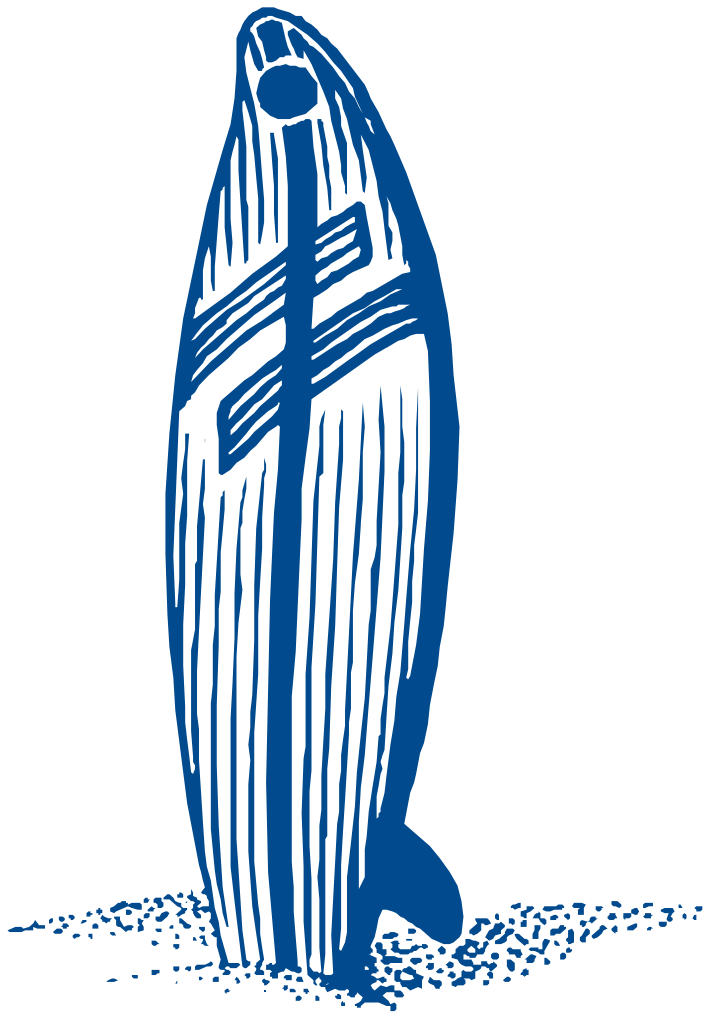
3. Which material do you want to use for your surfboard *fin(s)*? (Check one.)

_____ **Epoxy:** Manufacturers pour petroleum-based epoxy resin into molds and let it harden. Epoxy fins are lightweight and inexpensive.

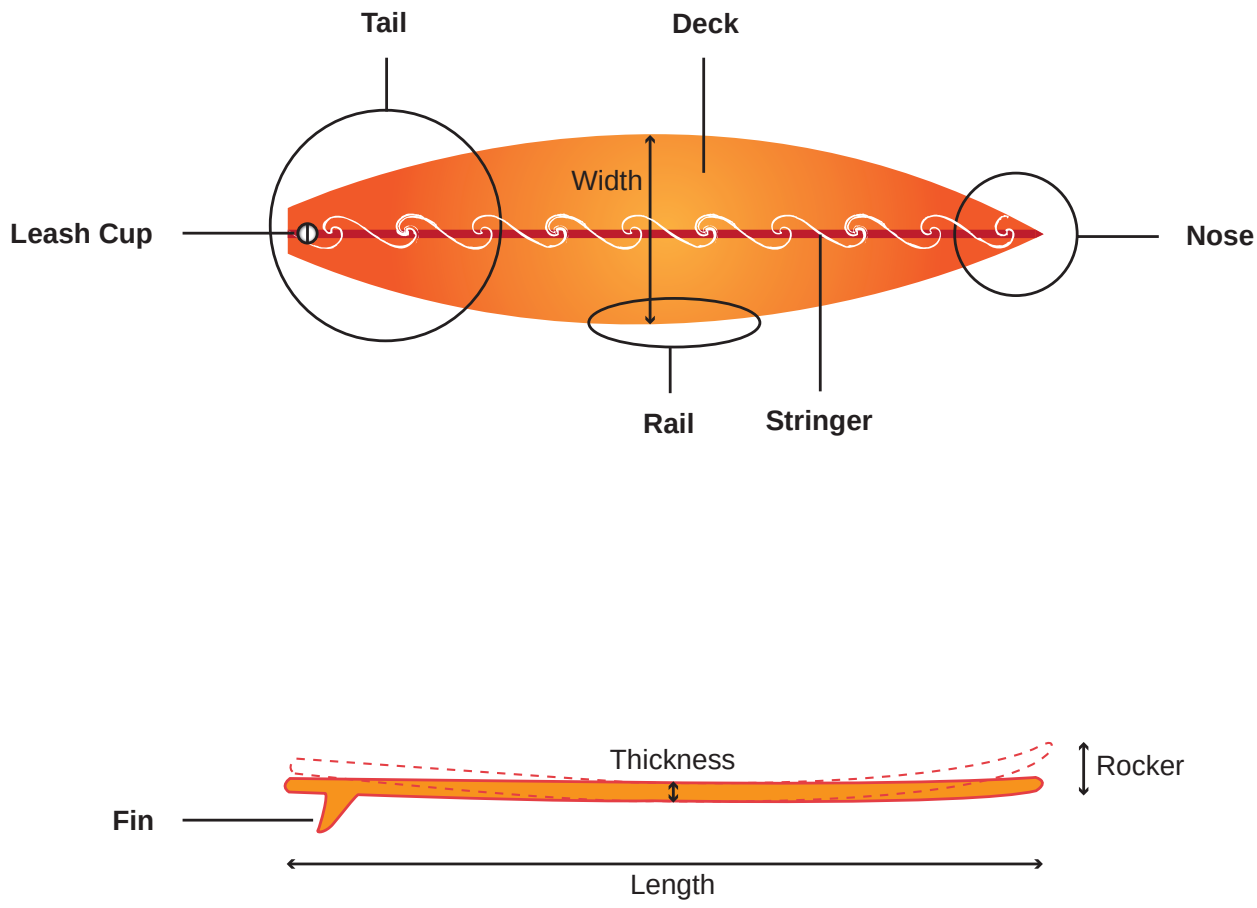
_____ **Fiberglass:** In fiberglass fins, layers of cloth made from glass thread are criss-crossed and pressed together. Fiberglass fins are strong.

_____ **Carbon:** This material is actually graphite, a mineral ore. Manufacturers mold it into shape for lightweight, strong, and flexible fins, which bend but do not break.

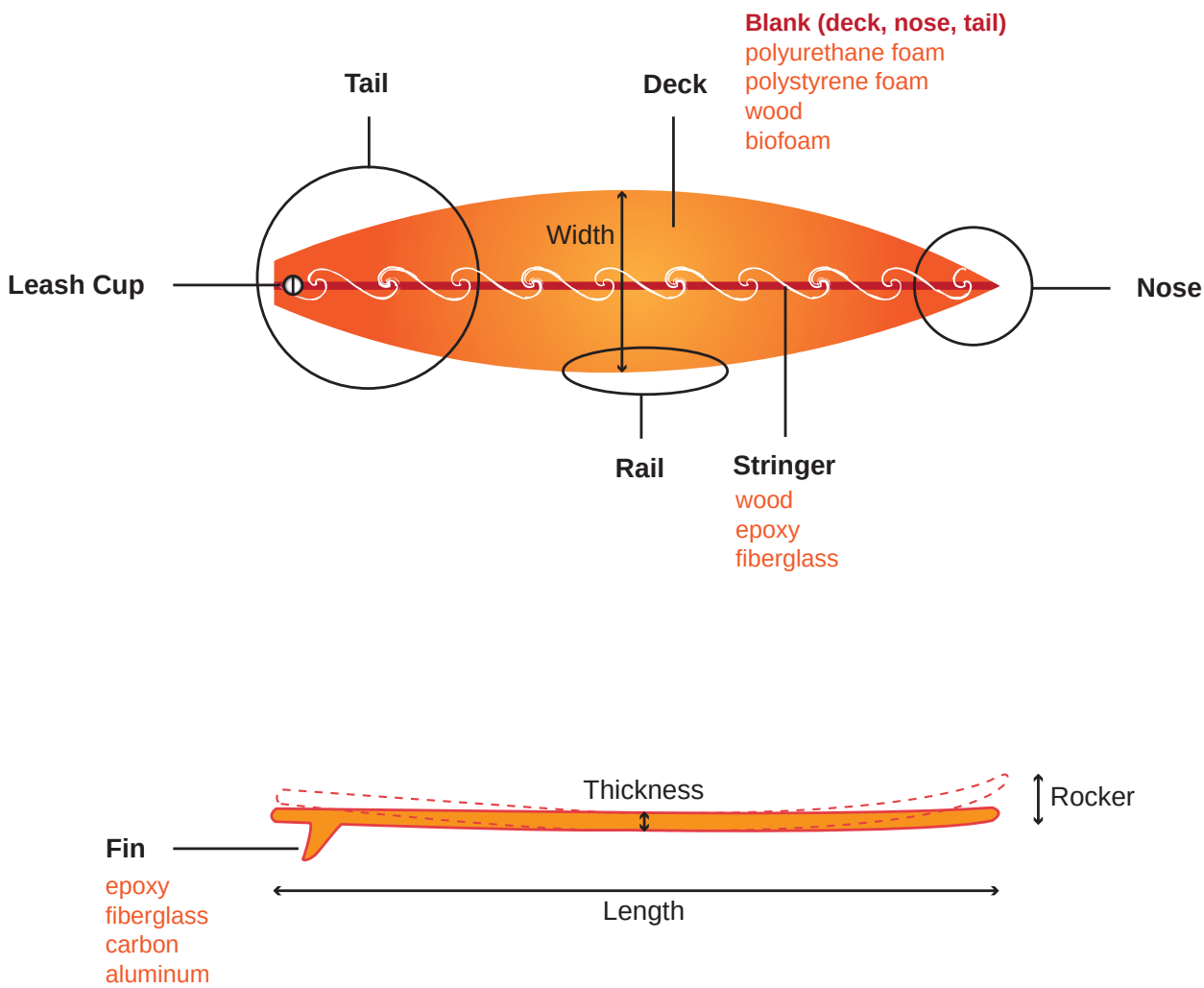
_____ **Aluminum:** Manufacturers form threads of aluminum (made from the mineral ore bauxite) into a cloth and sandwich cloth layers together for thickness and strength. Aluminum is the lightest material used in making fins.



Surfboard Design Blueprint #1



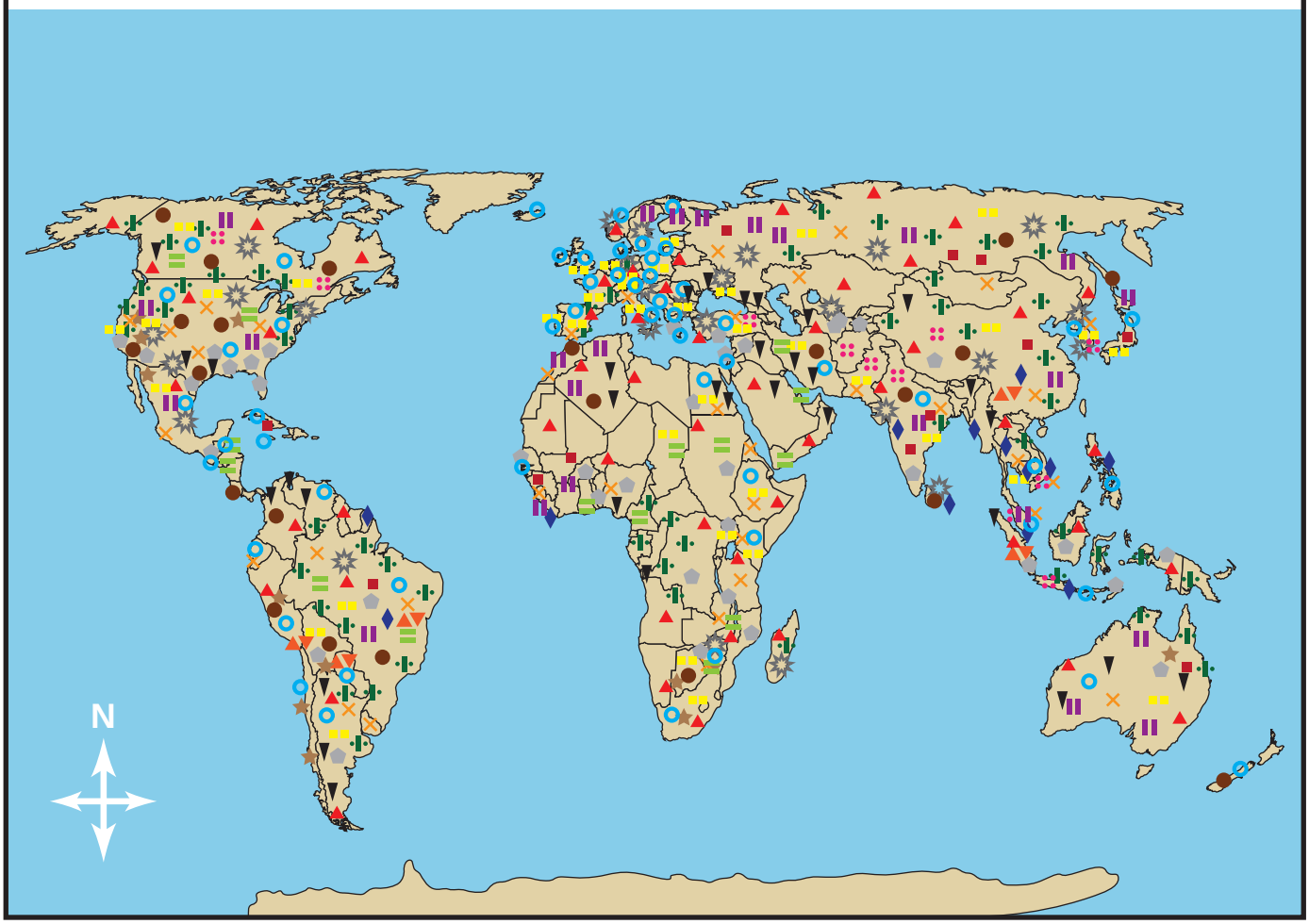
Surfboard Design Blueprint #2



A World of Resources

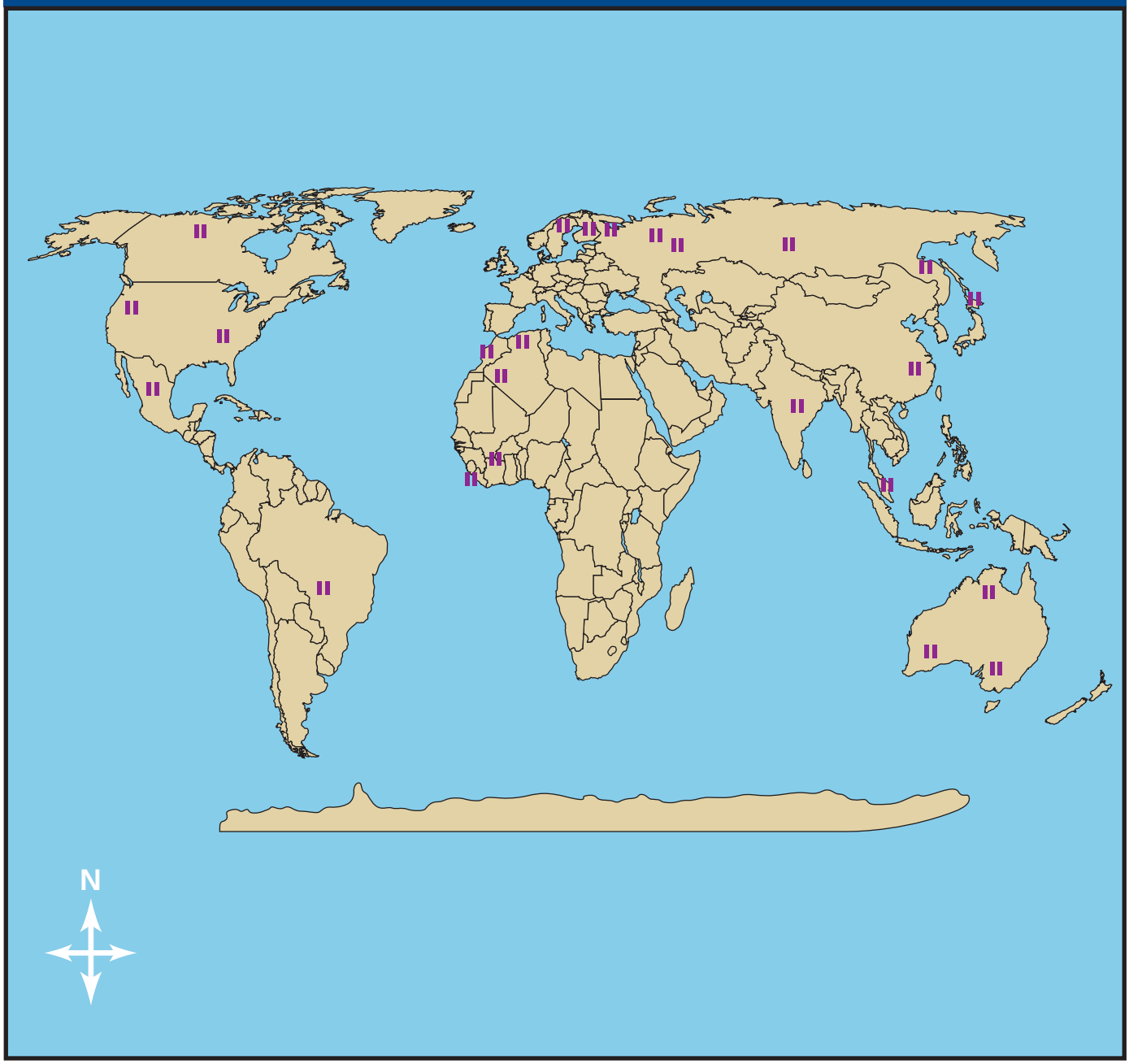
Raw Material Key

- Bauxite
- Clay
- Copper
- Cotton
- Gelatin
- Graphite
- Iron
- Leather
- Limestone
- Petroleum
- Resin (Rosin)
- Rubber (Natural)
- Silica/Quartz
- Soda Ash
- Tin
- Wood/Timber

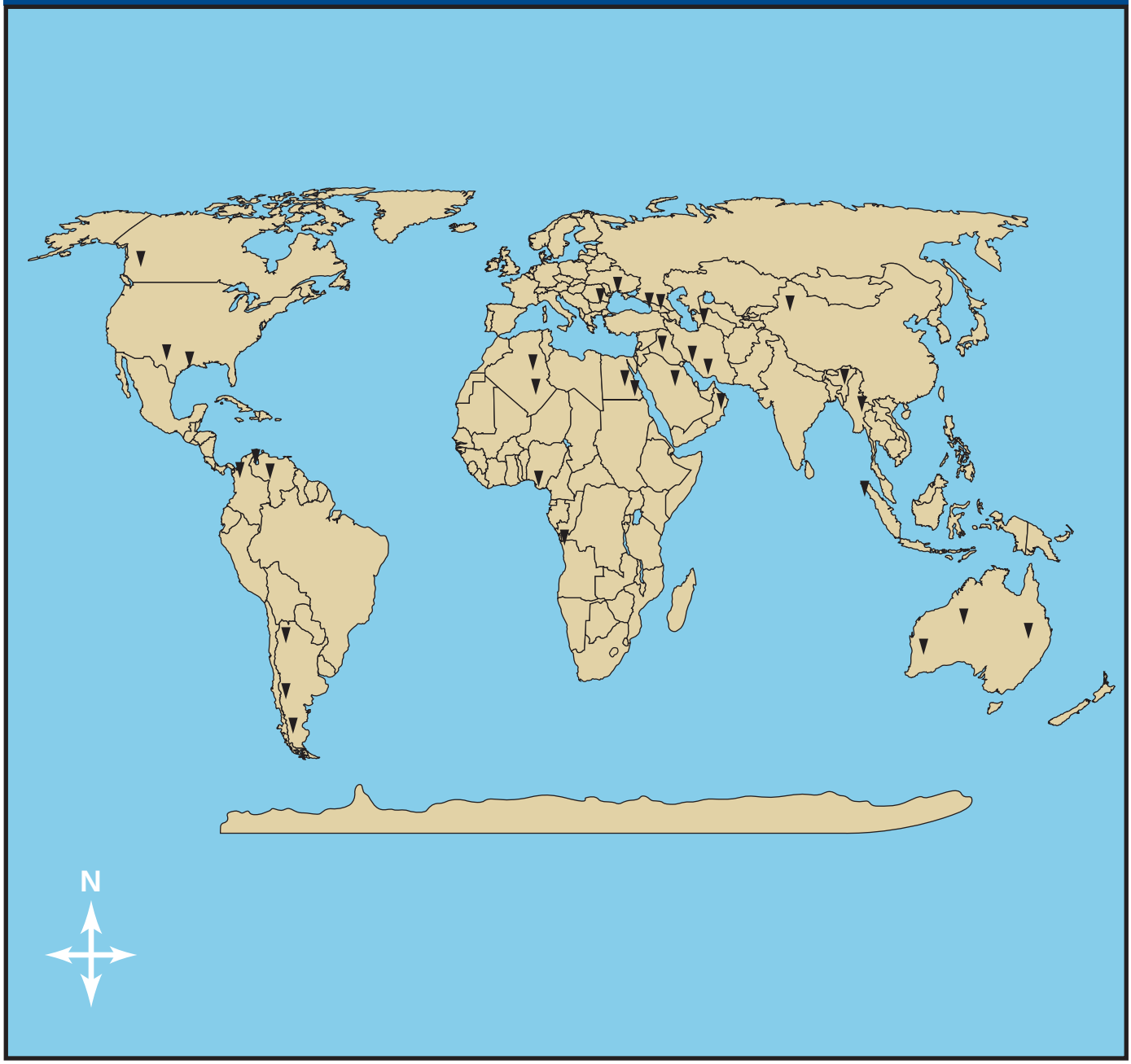


World Bauxite Distribution

World Iron Distribution

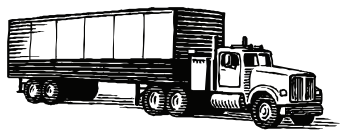


World Petroleum Distribution



Modes of Transportation in Industry

Percent use of large vehicles in industry.



49%

27%

15%

9%

Source: U.S. Department of Energy, Transportation Energy Data Book: Edition 26-2007.
Last Revised: October 2007

World Travelers

Step 1: Write the names of three resources you need to make your toy on the lines labelled Natural Resource #1, Natural Resource #2, and Natural Resource #3.

Step 2: Look at the chart on Page 6 (A World of Resources). Find your resources on the chart and write the estimated distance on the line labelled Distance transported.

Step 3: Circle your choice of how you will transport each resource to California.

Step 4: Add all the distances for a total estimate of how far the resources travel.

Name of natural resource #1: _____

Distance transported (estimate in miles) = _____

Type of Transportation Needed (circle one): Truck Train Aircraft Ship

Name of natural resource #2: _____

Distance transported (estimate in miles) = _____

Type of Transportation Needed (circle one): Truck Train Aircraft Ship

Name of natural resource #3: _____

Distance transported (estimate in miles) = _____

Type of Transportation Needed (circle one): Truck Train Aircraft Ship

Total estimated distance all cargo will travel: _____ **miles**

Job Description: Petroleum Extractor

You can find petroleum almost everywhere on Earth: below deserts, forests, mountains, and even oceans. However, it is often deep below the surface of the ground or water and can be hard to locate. As a petroleum extractor, your job is to mine petroleum, or crude oil, from deep under ground. You need to drill holes in the ground surface and use pumps to suck the liquid oil up to ground level, where you can use it.

Workers on an oil rig

Once you choose a site for drilling, you need to clear the area of all trees and plants. Next you need to drive a bulldozer over the cleared area to flatten the ground. After you make the ground level, you build a large platform to support the big drill you need to tunnel into the pocket of petroleum under ground. The platform and its drill are called a rig. The tallest part of the rig is a 100-foot (31-meter) tower called a derrick.

California oilwell

Inside the derrick sit steel pipes, which are screwed together to make one long pipe. At the end of the pipe is a sharp metal drill bit made with pieces of diamond at its tip. Diamond is the hardest mineral on Earth, so a diamond drill bit helps you dig through hard rock to get to the petroleum. Your handy drill also brings the cut rock from the drilled hole up to the ground surface, where you put the rock pieces into a big, plastic-lined pit. The plastic keeps petroleum from dripping onto the soil or into water near your drill site.

When your drill hits the right spot under ground, the petroleum might try to rush up to the surface. Fortunately, you predicted this would happen. To keep the petroleum from spraying up and all around, you installed a pump to push the oil into holding tanks. From the holding tanks, you take the crude oil to a refinery to be cleaned. Workers at the refinery may put the petroleum into barrels or other containers and send them to plastic manufacturers, gasoline manufacturers, or other companies that need petroleum to made materials or finished products.

Job Description: Wood Harvester (Logger)

Logger

Trees come in all shapes and sizes. As a logger, your job is to choose the right trees to cut down for wood. Maybe you work on a farm that grows a certain species of tree for harvesting or for a company that buys the right to harvest trees from public land. Either way, your first step is to design a plan for how you want to remove the trees from the area where you work.

To harvest trees from steep mountainsides or cut individual trees one at a time, you probably want to use a hand-held chainsaw. This type of motorized saw runs on gasoline. Some of the trees you cut down may be taller than 100 feet (31 meters). Using the chain saw, you make cuts into a tree near its base. If you cut properly, the tree falls away from you and crashes down on the forest floor.

To cut a group of trees at one time, you probably want to use a feller buncher. This vehicle has an arm in its front with saw blades or high-powered shears (like large scissors) instead of hands. When you drive the feller buncher into a group of trees, you turn on the blades or shears so you can cut through the trunks of dozens of trees in just a few minutes. Don't worry! The feller buncher stops the cut trees from falling on you.

After cutting the trees, you use the feller buncher or another machine to lift and stack the cut trees onto long trucks. The trucks transport the trees to the sawmill, where machines remove the branches and bark from each tree. The machines slice the trunks and large branches into pieces of lumber. Some trees get ground up into wood chips and others are made into pulp. Trucks transport the lumber, chips, and pulp to factories that make paper, furniture, or fabric. Some of the lumber goes straight to construction sites.

Feller buncher harvesting tree

Job Description: Copper Extractor (Miner)

Smelting copper

As a copper extractor, you dig tunnels into sides of mountains or down into the ground, where you find this resource. When you build a group of tunnels, you form a mine. Sometimes, you dig a large open pit in the ground instead of tunnels. Often the first step of your job is to cut down trees or remove the plants in an area you want to mine to make room for your equipment.

After you clear the way for your equipment, you use your drill to dig a hole into the ground or the side of a mountain. Stop drilling when your hole is a foot wide and 60 feet deep. Fill the hole with explosives, get out of the way, and set off a loud, powerful blast. Not only does the blast make a lot of noise, but it breaks thousands of pounds of rock into little pieces. Bring your trucks over to scoop up the hundreds of tons of rock. Next ship the pieces of rock off to be broken into even smaller pieces by a machine called a crusher.

Once you remove the pieces of rock from the crusher (which sometimes breaks the rocks into sand-sized pieces), send them over to a large metal tank, where they are mixed with water and chemicals. This mixture is called a slurry. A machine blows air into the slurry and creates bubbles. Copper sticks to the bubbles and the bubbles go into another tank, taking the copper with them. The rest of the slurry is dumped into a big pit you dug earlier near the mine. Water and chemicals evaporate from the pit into the air or seep into the ground.

But back to the copper bubbles. Your next step is to heat the tank with the copper and bubbles to 2,300ºF (1,260ºC). That temperature is hotter than lava in a Hawaiian volcano! The copper sinks to the bottom and a machine removes the waste and dumps it into another pit in the ground.

Now you need to cool the hot copper and let it harden. Finally, water and electricity are used to get pure copper out of what is left. Your last step is to shape the pure copper into rods and transport them to factories.

Copper miner

Job Description: Silica Extractor (Miner)

Quartz is the common name for silicon dioxide (SiO_2), or silica, and it sits close to Earth's surface. As a silica miner, you work at a special mine called a quarry. Another name for a quarry is an open-pit mine. Quarry mining does not use tunnels, because the minerals in these types of mines sit so close to the ground's surface you can almost reach down and pick them up!

Once you find an area that contains a lot of quartz (silica), you clear the trees and plants from a space the size of a football field.

Then loosen up the top layer of the ground. Use your drill to make about 150 holes in the ground. Each hole should be one foot wide and about 40 feet deep. Put a stick of dynamite in each hole and connect the dynamite's fuses with wire. Attach a detonator to the wire at safe distance from the blast field. After making sure your crew is out of the way, set off the dynamite and let the huge explosion lift the top of the ground. Now you can get to the layers of quartz rock below.

It's time for your bulldozers and backhoes. Drive them over to the blast area and carry the loose ground cover away. (You might want to save it nearby for later to cover up the area where you are working, once you are done. Or you could sell the soil to gardeners or farmers.) Next bring in your jackhammers and mechanical picks to break apart the exposed quartz rock.

Silica excavator

Sand quarry

Now the trucks waiting nearby can bring over their huge shovels and grab up to 24 tons of quartz rock and carry the quartz to a crusher. The crusher machine grinds quartz rocks into soft, white sand. You are ready to send the silica sand out by truck to glass factories and silicon refineries or to construction sites and beaches.

Job Description: Cotton Harvester (Farmer)

Cotton is a plant that grows well in warm tropical or subtropical parts of the world. For a good crop, you want soil that is crumbly but will hold water and a place where the plants will have sun for more than 160 days in a row. You can plant the seeds in rows that are close together, and they will still sprout. Make sure you keep the soil wet.

Seedlings appear about five days after you plant the seeds with your planting machine. The plants begin to flower after five or six weeks, and in another three or five weeks the flower buds open. Each cotton flower loses its petals after three days. The petals leave behind a small seed pouch, known as a boll. White cotton flowers grow around the seeds from the boll. Ten weeks after flowering, the bolls split and the raw cotton fibers burst and begin to dry in the sun.

You can pick the bolls off the cotton plants by hand, but if your land is flat enough you can use cotton harvesting machines to collect the bolls. The machines cut down the entire cotton plant, so you will still need to separate the boll from the rest of the plant. Using a warm-air machine, like a clothes dryer at a Laundromat, you dry out your bolls in large tubes.

After drying the bolls, separate the seeds and boll coverings from the cotton fibers using your cotton gin machine. Each boll has as many as 30 seeds, and you ship the seeds to factories where they are pressed to make cottonseed oil. Gather together the cotton fibers into large round or rectangular shapes called bales. Now ship those bales to a mill or factory to be spun into thread and cloth.

Modern cotton farmer

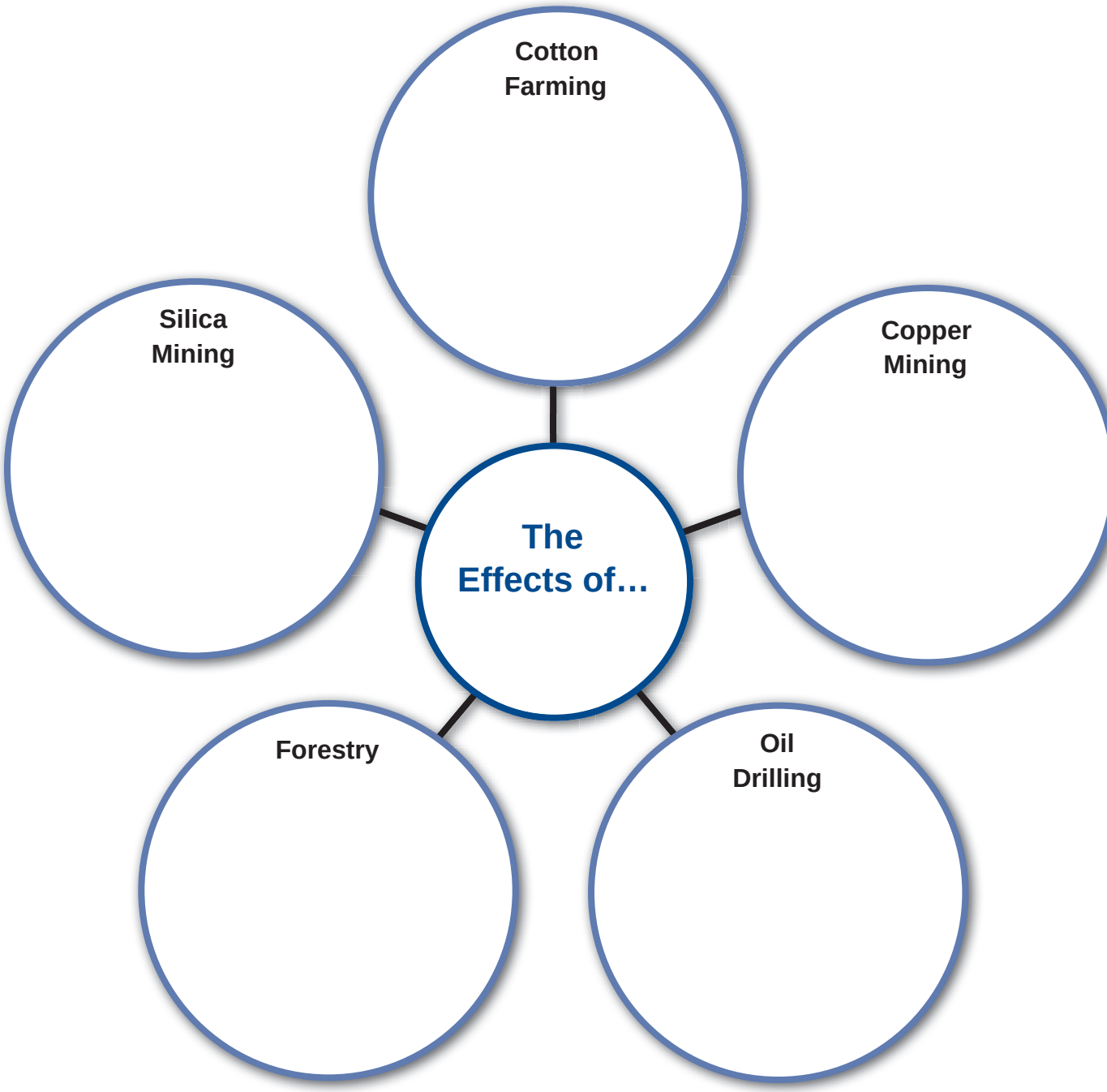
Harvesting cotton in California

Resources

Resources

Resources

Name: _____

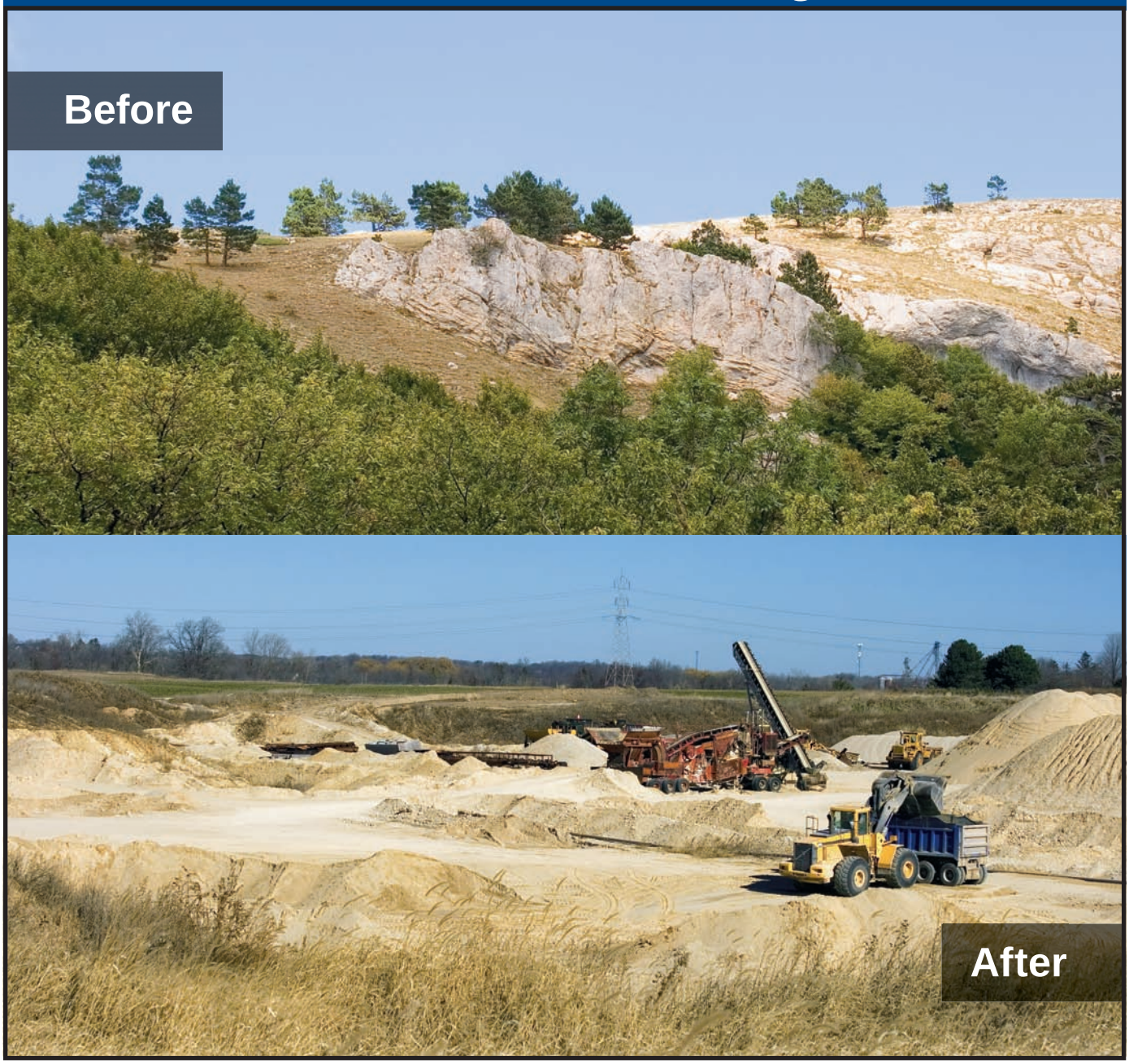

Cotton Farming
Silica Mining
Copper Mining
The Effects of…
Forestry
Oil Drilling

Before and After: Copper Mining

Before and After: Cotton Farming

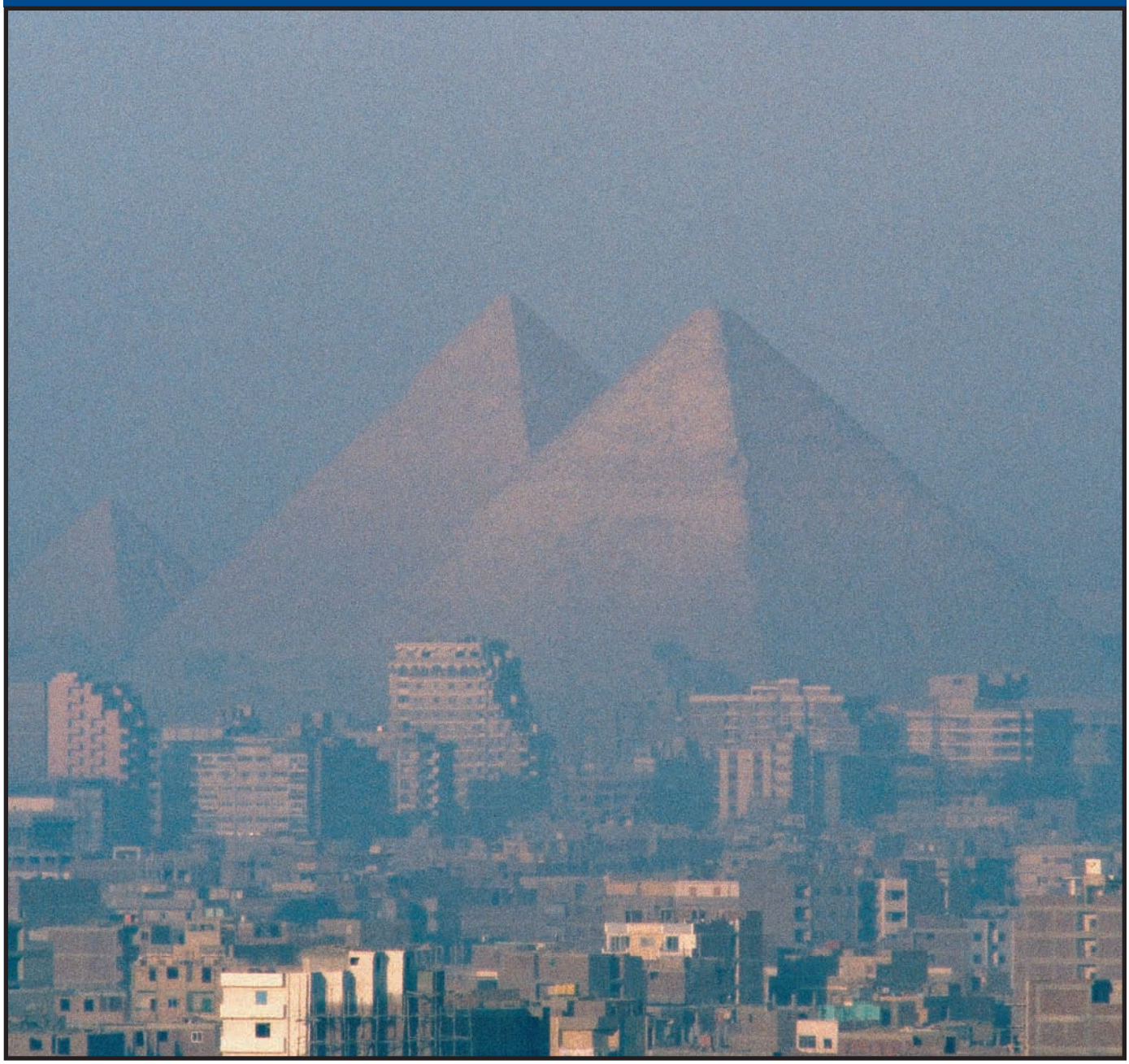
Before and After: Oil Drilling

Before and After: Silica Mining



Before and After: Forest Clear Cutting

Air Pollution in Cairo, Egypt



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